Linx TECHNOLOGIES

HS Long-Range Handheld Transmitter Master Development System

User´s Guide

Wireless made simple®

Warning: Some customers may want Linx radio frequency ("RF") products to control machinery or devices remotely, including machinery or devices that can cause death, bodily injuries, and/or property damage if improperly or inadvertently triggered, particularly in industrial settings or other applications implicating life-safety concerns ("Life and Property Safety Situations").

NO OEM LINX REMOTE CONTROL OR FUNCTION MODULE SHOULD EVER BE USED IN LIFE AND PROPERTY SAFETY SITUATIONS. No OEM Linx Remote Control or Function Module should be modified for Life and Property Safety Situations. Such modification cannot provide sufficient safety and will void the product's regulatory certification and warranty.

Customers may use our (non-Function) Modules, Antenna and Connectors as part of other systems in Life Safety Situations, but only with necessary and industry appropriate redundancies and in compliance with applicable safety standards, including without limitation, ANSI and NFPA standards. It is solely the responsibility of any Linx customer who uses one or more of these products to incorporate appropriate redundancies and safety standards for the Life and Property Safety Situation application.

Do not use this or any Linx product to trigger an action directly from the data line or RSSI lines without a protocol or encoder/decoder to validate the data. Without validation, any signal from another unrelated transmitter in the environment received by the module could inadvertently trigger the action.

All RF products are susceptible to RF interference that can prevent communication. RF products without frequency agility or hopping implemented are more subject to interference. This module does not have a frequency hopping protocol built in.

Do not use any Linx product over the limits in this data guide. Excessive voltage or extended operation at the maximum voltage could cause product failure. Exceeding the reflow temperature profile could cause product failure which is not immediately evident.

Do not make any physical or electrical modifications to any Linx product. This will void the warranty and regulatory and UL certifications and may cause product failure which is not immediately evident.

Table of Contents

1 Introduction
2 Ordering Information
2 HS Series Decoder Development Board
3 Using the Development Boards
3 Troubleshooting
4 Security Overview
6 Typical System Setup
7 Using the Optional Keypad Pin
8 Contention Considerations
8 Battery Replacement
8 OTX-***-HH-LR8-HS Button Assignments
9 Assembly Diagram
10 The Decoder Board
15 Installing the Software and Drivers
16 Master Development Software
19 Resources

HS Long-Range Handheld Transmitter Master Development System

Data Guide

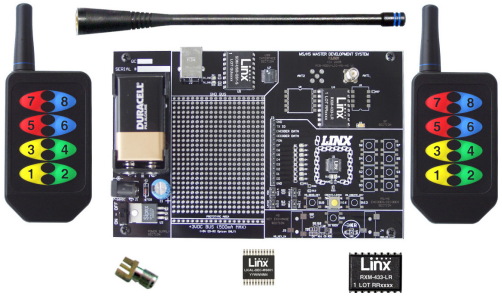

Figure 1: HS Long-Range Handheld Transmitter Master Development System

Introduction

The Linx HS Long-Range Handheld transmitter offers a simple, efficient and cost-effective method of adding secure remote control capabilities to any product. This Master Development System gives a designer all the tools necessary to incorporate the transmitter, LR Series receiver and HS Series decoder into a product. The Master Development System serves several important functions:

- Rapid Evaluation: It allows the performance and features of the transmitter, LR Series receiver and HS Series encoders and decoders to be evaluated quickly in a user's environment.
- Range Testing: The transmitter and receiver board form a full remote control system so that the range performance can be evaluated.
- Design Benchmark: The boards provide a known benchmark against which the performance of a custom design may be judged.
- Application Development: An onboard prototyping area allows for the development of custom circuits directly on the development board. All signal lines are available on a header for easy access.

The Master Development System includes 2 HS Long-Range Handheld transmitters, 2 LR Series receivers*, 2 HS Series decoders*, 1 receiver / decoder development board,1 CW Series antenna, demonstration software CD and full documentation.

*One part is soldered to the board, one extra is for use on your first prototype board

Ordering Information

Ordering Information	
Part Number	**Description**
MDEV-***-HH-LR8-HS	HS Long-Range Transmitter Master Development System

*** = 315, 418 (Standard) or 433.92MHz

Figure 2: Ordering Information

HS Series Decoder Development Board

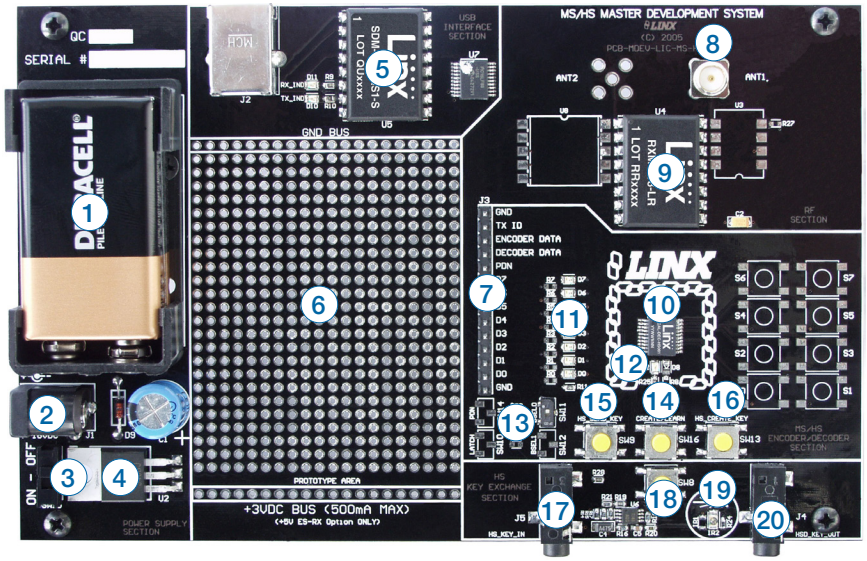

Figure 3: The HS Series Decoder Development Board

1. 9V Battery
2. Power Jack
3. On-Off Switch
4. Voltage Regulator
5. QS Series USB Module
6. Prototype Area
7. Break-Out Header
8. RP-SMA Antenna Connector
9. LR Series Receiver
10. HS Series Decoder
11. Data Line LEDs
12. Indicator LEDs
13. Function Switches
14. LEARN Button
15. SEND_KEY Button
16. CREATE_KEY Button
17. Key Input Jack (for hardwire key transfer)
18. IR Receiver Enable Button
19. IR Key Transfer Phototransistor and Diode (for IR key transfer)
20. Key Output Jack (for hardwire key transfer)

Using the Development Boards

After unpacking the development system, attach an antenna to the decoder board, install the 9V battery and turn on the power switch. **The encoder and decoder are set at the factory to work straight out of the box.** To create a new operational setup, follow these steps:

1. On the decoder board, press and hold the LEARN button and then press the CREATE_KEY button to enter Create Key Mode. Release the LEARN button and press the CREATE_KEY button ten times to generate the KEY.
2. Press the GET_KEY button on the back of the transmitter to activate the IR receiver. Hold the back of the transmitter close to the decoder boards's IR key transfer area until the MODE_IND LED turns on.
3. Set Control Permissions by pressing the LEARN button on the decoder board.
4. While the decoder's MODE_IND line is flashing, press each button on the transmitter that is to be granted recognition permission.
5. After all the desired data lines have been transmitted, press the LEARN button again, or wait until the 15 second time-out occurs. The permissions are now saved in the decoder.
6. Transmit with one or all of the authorized data lines to confirm that the learn process was successful.

Troubleshooting

If the boards fail to work out of the box, then try the following:

- Check the batteries to make sure they are not dead and that the antenna is connected.
- Make sure the baud rate switch is set correctly on the decoder board.
- Make sure the Encryption Key is set correctly. It is created by the decoder and must be sent to the encoder before they can communicate.
- Make sure that the Control Permissions are set correctly. If the transmitter has not been set to use a particular line, then when a button on the transmitter is pressed, the MODE_IND LED on the decoder board lights up, but the data line LED does not light up.

If all of these appear to be in order, then call +1 800 736 6677 or e-mail techsupport@linxtechnologies.com for technical support.

Security Overview

The HS Long-Range Handheld transmitter uses the HS Series encoder, which is based on CipherLinx™ technology. CipherLinx™ is a high-security encryption algorithm and wireless protocol designed for remote control and remote keyless entry applications. It provides a much greater level of security and many more features than older technologies on the market, such as fixed address or “rolling code” systems. Additionally, the CipherLinx™ transmission protocol is much more advanced than the simple PWM method employed by many systems. By utilizing an advanced serial protocol for data, CipherLinx™ is able to offer superior noise immunity, greater range, and increased link reliability, all of which are key factors in a wireless system.

Figure 4: CipherLinx Logo

CipherLinx™ never sends or accepts the same data twice, never loses sync, and changes codes with every packet, not just every button press. CipherLinx™ encryption is based on the Skipjack cipher developed by the U.S. National Security Agency (NSA), and is widely considered one of the most secure ciphers available. There have been no known successful attacks on the full Skipjack algorithm. Skipjack is a block cipher that has 80-bit keys and 64-bit data blocks. Since each packet is longer that 64 bits, Skipjack is employed in an encryption mode. The particular encryption mode chosen for CipherLinx™ is based on the CMC encryption mode, so that the resulting cipher is a special kind of function known as a “strong PRP” (sPRP). The encryption mode uses several invocations of Skipjack to encrypt the 128 bits in each message.

The Skipjack algorithm used by Linx has been proven secure and is not modified to avoid any compromise of strength. CipherLinx™ is far more than just a Skipjack implementation. CipherLinx's patent-pending technology combines multiple calls to the encryption algorithm with a proprietary mixing algorithm. CipherLinx™ encryption, as implemented in the Linx HS Series, has been independently evaluated by Independent Security Evaluators (ISE), a respected security firm that is widely recognized for its expertise in electronic security. They concluded that “the CipherLinx(™) protocol in the HS Series is well-designed and is an excellent choice for applications requiring a secure unidirectional link.” ISE’s full evaluation report can be found at www.linxtechnologies.com. In summary, CipherLinx™ is a powerful, independently verified, secure encryption technology that is well-suited to a wide range of applications.

In addition to this high level of security, CipherLinx™ also offers a number of features that are unique among remote control products. These include a large number of data lines, internal key generation, “button level” control permissions, an optional encoder PIN, as well as the ability for the decoder to identify the originating encoder. Please refer to the HS Series encoder and decoder data guides for full details.

Typical System Setup

The HS Series Long-Range Handheld Transmitter is intended to make user setup straightforward while ensuring the highest possible security. This inherent ease of use can be illustrated by a typical user setup. The Typical Applications section of the HS Series Decoder Data Guide shows the circuit schematics on which the receiver examples are based.

1. **Create an exchange a key from a decoder to the transmitter.**
   The handheld transmitter includes an on-board infrared receiver designed to optically receive the decoder's key transmission. Sending the key in this manner preserves security while avoiding the need for a hardwire connection.

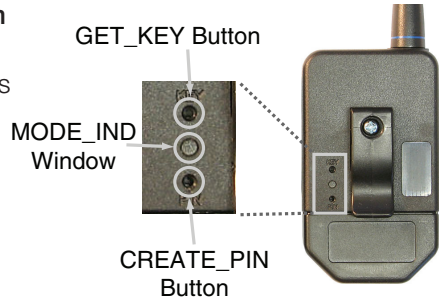

Figure 5: Button Access Holes

   The high security key is created and exchanged by placing the decoder in the Create Key Mode. The decoder's MODE_IND LED lights to indicate that the decoder has entered Create Key Mode. The decoder's CREATE_KEY button is then pressed ten times to create the key. After the tenth press, the MODE_IND LED turns off and the decoder outputs the key via a 900nm infrared diode on the KEY_OUT line. A paper clip is used to press the GET_KEY button on the back of the transmitter. Hold the back of the transmitter near the decoder's infrared diode within twenty seconds. Once the key has been transferred, the MODE_IND LEDs on both the transmitter and decoder illuminate to indicate success.

2. **Establish Control Permissions**
   Next, the user defines which buttons on the transmitter should be acknowledged by the decoder. The HS Series Control Permissions allow each transmitter in a system to activate different data lines. This is especially useful in applications where differing user access or activation capabilities are desired.

   Consider this example: a three-door garage houses Dad's Corvette, Mom's Mercedes, and Son's Yugo. With most competitive products, any keyfob could open any garage door as long as the addresses match. In an HS-based system, the keyfobs could easily be configured to open only certain doors (guess which one Son gets to open!). Setting the control permissions is intuitive. The user presses the decoder's LEARN button. The decoder's MODE_IND LED starts flashing and the user simply presses the handheld transmitter buttons that should be recognized. Control Permissions are stored when the LEARN button is pressed again or automatically after seventeen seconds.

   There are other powerful options, such as programming a user PIN or copying a decoder, but these two steps are all that is required for a typical setup.

Using the Optional Keypad Pin

For higher security applications, the HS Series encoder has the option to set a Personal Identification Number (PIN) to control access to the encoder. This PIN is a four-button combination of the eight buttons which must be entered before the transmitter will send any commands. It needs to be re-entered after fifteen minutes of inactivity. If no PIN is created, then the transmitter activates as soon as a button is pressed.

Creation of a Keypad PIN

1. Use a paper clip to press the CREATE_PIN button on the back of the transmitter. The MODE_IND LED begins flashing until either a PIN is successfully entered or fifteen seconds has passed.
2. To enter the PIN, press a sequence of any four buttons. The MODE_IND stops flashing and the PIN is created.
3. To cancel Create PIN Mode prior to the fourth entry, either wait for the fifteen second timeout to pass or press the CREATE_PIN button. The MODE_IND LED stops flashing and no PIN is created.
4. If a new KEY is created, the PIN is automatically erased.

Using the PIN

1. The PIN is entered by pressing each button until all four entries have been made. There is a maximum two-second time limit between entries, after which the PIN must be re-entered in its entirety.
2. Once the PIN is successfully entered, the transmitter is operational unless it is inactive for fifteen minutes, in which case the PIN must be re-entered.

Contention Considerations

It is important to understand that only one transmitter at a time can be activated within a reception area. While the transmitted signal consists of encoded digital data, only one carrier of any particular frequency can occupy airspace without contention at any given time. If two transmitters are activated in the same area at the same time, then the signals will interfere with each other and the decoder will not see a valid transmission, so it will not take any action.

Battery Replacement

The remote unit utilizes a standard CR2032 lithium button cell. In normal use, it provides 1 to 2 years of operation. To replace the battery, remove the access cover by pressing firmly on the label area and sliding it off. Once the unit is open, remove the battery by sliding it from beneath the holder. Replace it with the same type of battery while observing the polarity shown in Figure 6.

There may be the risk of explosion if the battery is replaced by the wrong type.

Figure 6: Battery Access

OTX-***-HH-LR8-HS Button Assignments

Figure 7 illustrates the relationship between the button locations and encoder data lines.

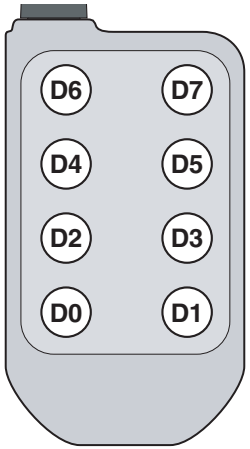

Figure 7: OTX-***-HH-CP8-HS Button Assignments

Assembly Diagram

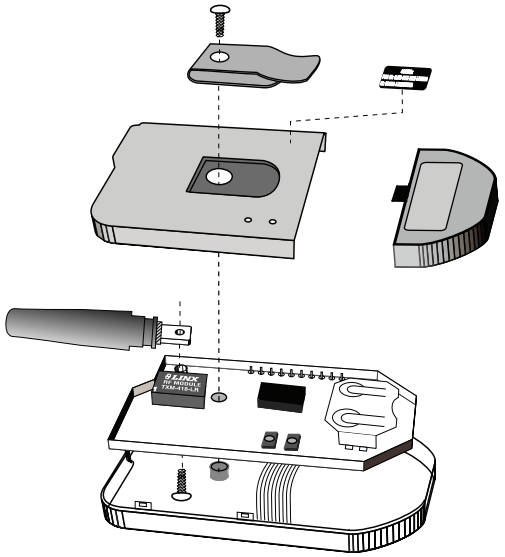

Figure 8: OTX-***-HH-LR8-HS Assembly

The Decoder Board

The decoder board has six main sections of interest: the decoder area, the RF area, the USB area, the key exchange area, the power supply and the prototyping area.

The Decoder Area

Figure 9 shows the decoder area of the development board.

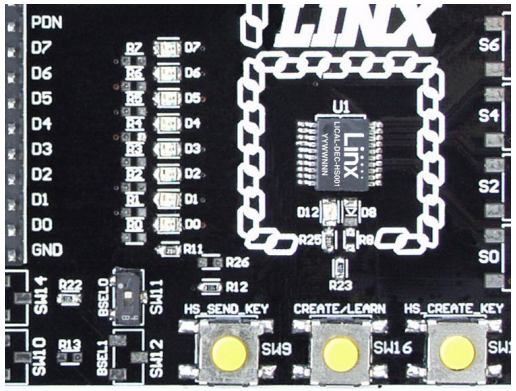

Figure 9: The Decoder Area

The decoder is located in the center beneath the Linx logo. To the left are LEDs which are connected to the decoder data lines. These light up when the decoder receives a signal from the encoder to take the data line high. LED D0 corresponds to data line D0, and so forth.

Beneath the decoder is an LED that is connected to the MODE_IND line. This lights up as described in the HS Series Decoder Data Guide.

Beneath the LED are three buttons. The one on the left labeled HS_SEND_KEY is connected to the SEND_COPY line on the decoder. The one in the middle is connected to the LEARN line, and the one on the right is connected to the CREATE_KEY line. The HS_SEND_KEY button causes the decoder to begin sending a copy of its User Data when pressed at the same time as the LEARN button. The LEARN button is used to learn the Control Permissions from the encoder and, with the other two buttons, to make the decoder enter special modes. The CREATE_KEY button causes the decoder to create a new key when pressed at the same time as the LEARN button. All of these functions are described in detail in the HS Series Decoder Data Guide.

There is one function switch to the left of the CREATE button. BSEL0 is used to set the baud rate of the decoder as described in Figure 10. The transmitter is set to 4,800bps, so this switch must be in the down position.

BSEL0	Baud Rate (bps)
0	4,800
1	28,800

Figure 10: Baud Rate Selection Table

The Decoder Board RF Area

Figure 11 shows the RF area of the development board.
This board is populated with the LR Series receiver. The ANT1 connector is

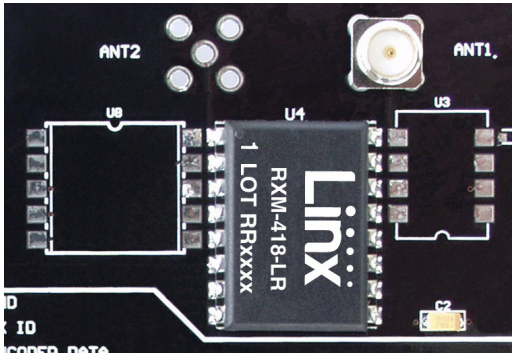

Figure 11: The Decoder Board RF Area

provided for attachment of the included antenna.

The Decoder Board USB Area

The decoder development board has a Linx SDM-USB-QS-S module for use with the included development software. This module is powered by the USB bus, so it does not pull any current from the battery. Figure 12 shows the USB area on the decoder board.

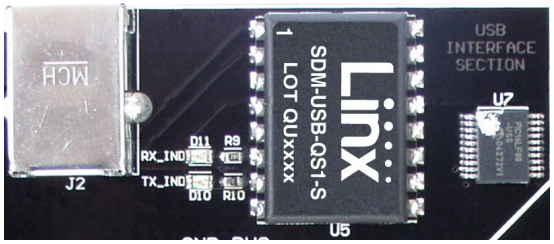

Figure 12: The Decoder Board USB Area

The microcontroller on the right monitors the decoder data lines and generates commands that are sent to the development software on the PC via the QS Series USB module. The RX_IND LED to the left of the module flashes to indicate that data is being received from the microcontroller.

The Decoder Board Key Exchange Area

Figure 13 shows the key exchange area of the development board.

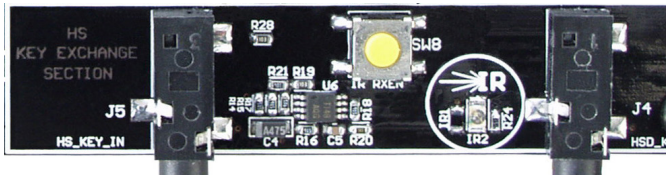

Figure 13: The Decoder Board Key Exchange Area

The key is created in the decoder and transferred to the transmitter with an infrared (IR) link. This consists of an infrared diode (IR2) that is modulated by the KEY_OUT line of the decoder and an infrared receiver built into the transmitter. Once the key is created, the decoder outputs the key information through this circuit. The clear plastic window on the back of the transmitter should be held within a few inches of the infrared diode and the key transfer happens automatically. Jack J4 is also connected to the KEY_OUT line and is available for wired transfer of the key, but the handheld transmitter is not adapted to accept a wired connection. The rest of the circuitry is used for sending and receiving copies of the decoder's User Data, as described in the HS Series Decoder Data Guide, but is not required for operation of this development system.

The Power Supply

The power supply consists of a 9V battery and a power jack connected to a 3.0V voltage regulator. The regulator can provide approximately 500mA of current to the prototyping area. If the added circuitry needs more than this, then an external supply must be added. If the circuit consistently draws more than 100mA of current, it might be better to use the power jack, as the battery will run down fairly quickly, reducing testing and development time.

The jack accepts a standard 5.5mm plug with the tip ground and the outer shell 7 to 16VDC positive supply. A reverse voltage protection diode has been included on the board to protect the circuitry in case the voltage on the plug is reversed, but it is still a good idea to double-check the polarity.

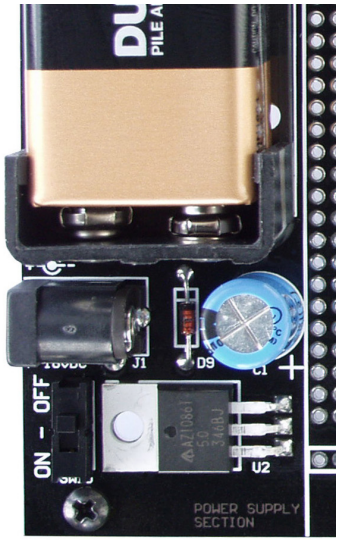

Figure 14: The Power Supply Area

The Prototyping Area

The prototyping area contains a large area of plated through holes so that external circuitry can be placed on the board. This circuitry can be interfaced with the HS decoder through the breakout header to the right. At the bottom of this area is a row connected to the 3V power supply and at the top is a row connected to ground.

All of the data lines are connected to a wire-wrap header to the right, allowing easy access from the prototyping area. The decoder DATA_IN and TX_ID lines are also available on the header, as well as the PDN line from the receiver. This allows complete control of the entire system from the prototyping area, giving the designer a great deal of flexibility in using the boards.

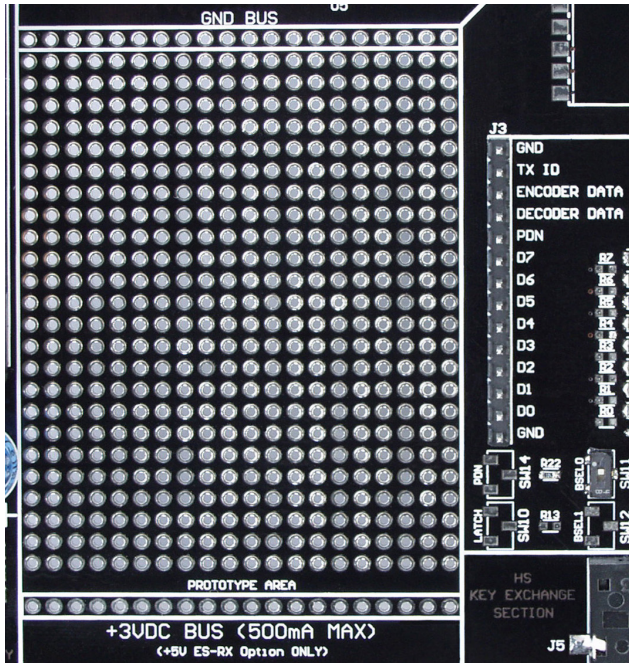

Figure 15: The Prototyping Area

Installing the Software and Drivers

The Master Development System uses the QS Series USB module to provide a simple serial interface to a PC via a USB connection. The module requires drivers to be installed on the PC before it can function properly. The QS Series Drivers are included on the CD with the software.

The first time the QS module is plugged into the computer, Windows displays the Found New Hardware Wizard, which guides the installation of the drivers. Application Note AN-00201 describes the installation of the drivers in detail. The drivers should be installed before running the Development Software.

The HS Master Development Software automatically starts when the CD is inserted and the player in Figure 16 appears.

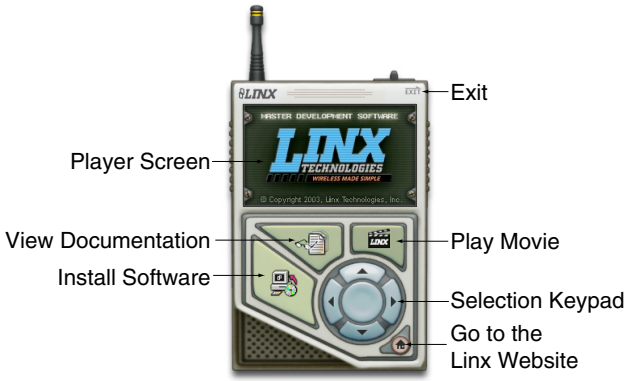

Figure 16: Software Installer

Clicking the Install Software button starts the Installation Wizard, which guides the installation of the development software. The View Documentation button shows a list of the application notes and manuals related to the HS Series. Selecting one of these opens the file in Adobe Acrobat. The Play Movie button plays a short video about Linx on the Player Screen, which can be controlled with the Selection Keypad. Clicking the button on the bottom right of the player opens the Linx Technologies website in the computer's default browser.

The View Documentation list allows for the installation of Adobe Acrobat Reader so that the documents may be viewed. There is also the option of installing Flash, which may be required if the Linx video does not play correctly.

Master Development Software

This software gives a complete understanding of how the HS Series encoders and decoders work together, as well as showing how they are used in a system.

The Master Development software can be used in one of two modes. The default mode is a software simulation of the system and does not require any hardware. It simulates two handheld transmitters as well as two receiving devices. This is a good way to illustrate how the HS Series works in a system by turning on lights and opening doors.

The second mode is for use with the Master Development System. When the decoder board is plugged into a USB port on the PC, the transmitter can be used to activate the features in the software. If the LEDs on the evaluation board turn on, then the LEDs in the program turn on and activate the corresponding data line function.

Figure 17 is a screen shot of the program set up in Software Operation Mode for simulating the operation of the system.

Figure 17: HS Encoder / Decoder Demonstration Software

The transmitters are on the right hand side and the receivers are at the bottom. Complete instructions for using the software can be found by clicking on the Help label at the top right of the window.

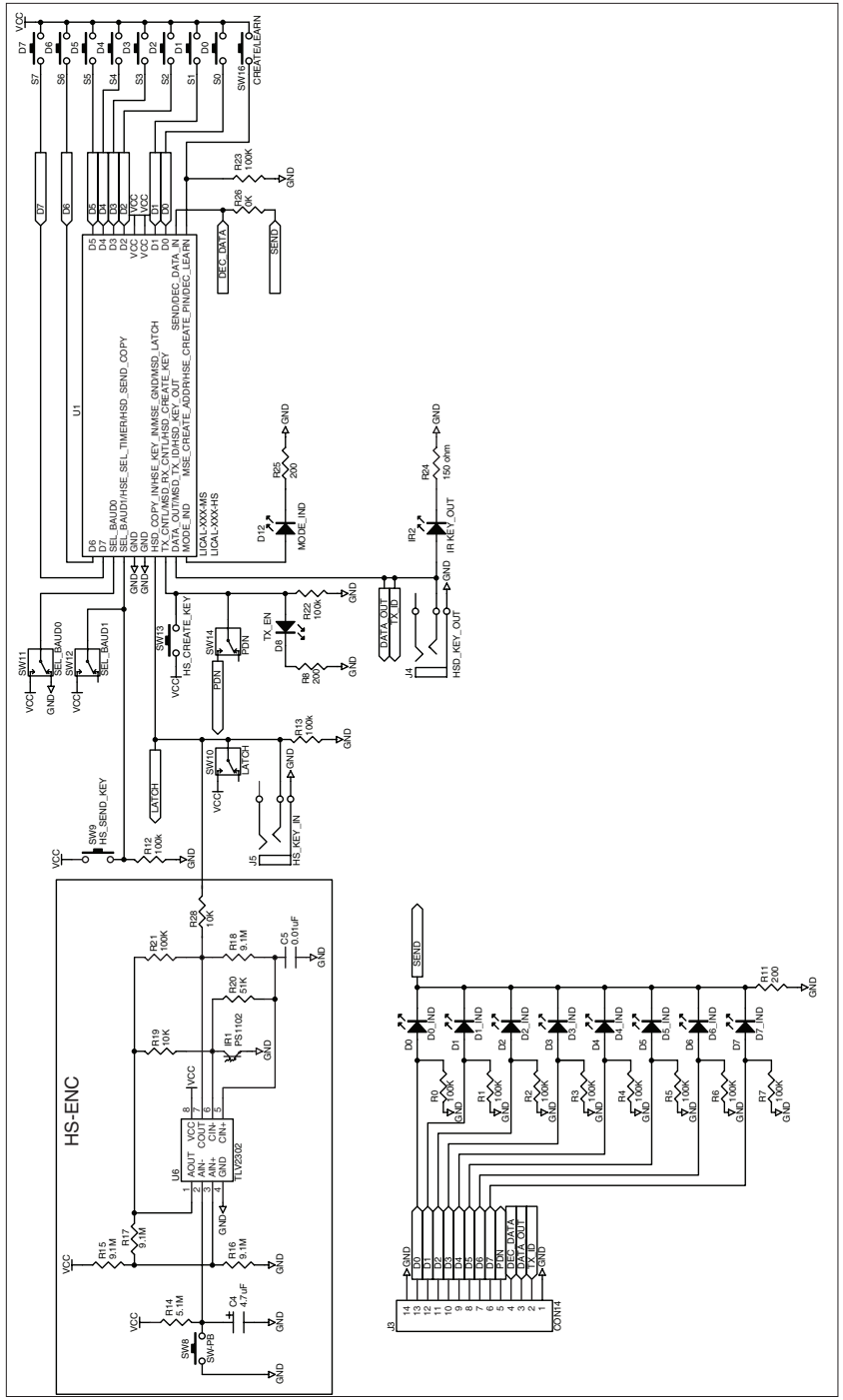

Figure 18: Encoder / Decoder Section Schematic Diagram

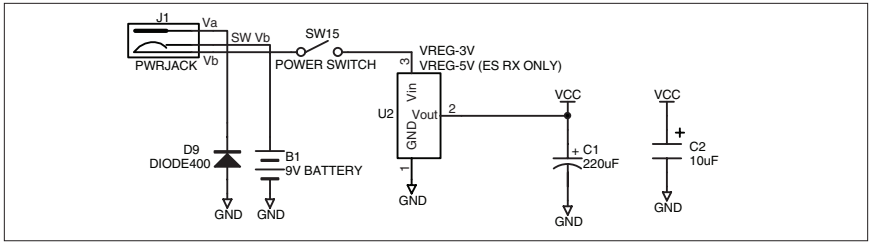

Figure 19: Power Supply Section Schematic Diagram

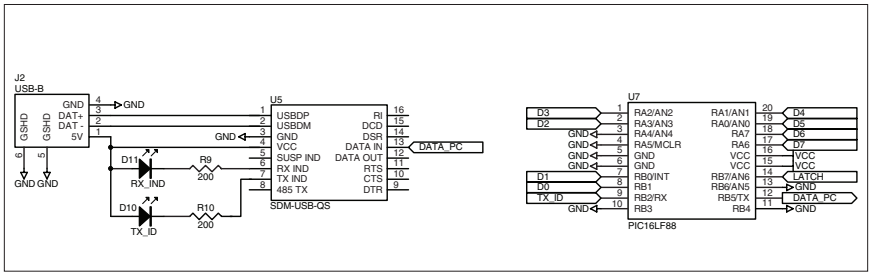

Figure 20: USB Section Schematic Diagram

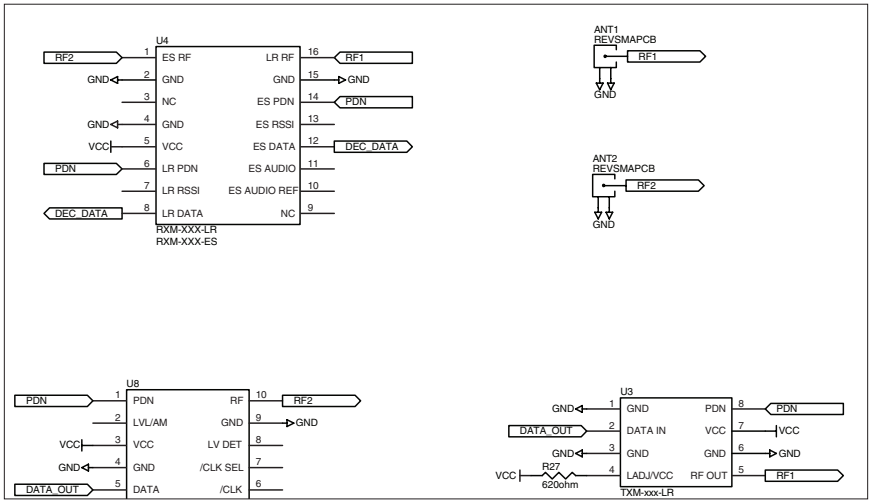

Figure 21: RF Section Schematic Diagram

Resources

Support

For technical support, product documentation, application notes, regulatory guidelines and software updates, visit www.linxtechnologies.com

RF Design Services

For customers who need help implementing Linx modules, Linx offers design services including board layout assistance, programming, certification advice and packaging design. For more complex RF solutions, Apex Wireless, a division of Linx Technologies, creates optimized designs with RF components and firmware selected for the customer's application. Call +1 800 736 6677 (+1 541 471 6256 if outside the United States) for more information.

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